Zooplankton

Similar to phytoplankton, zooplankton are essential to marine ecosystems as the basis of the food web (Bourdonnais et al., 2024). Zooplankton act as grazers of algae and bacteria in the marine ecosystems and thus are at a higher trophic level than phytoplankton (Lomartire et al., 2021). In their turn, zooplankton are directly connected to all plankton consuming organisms in the environment (Lomartire et al., 2021), which causes zooplankton to strongly affect both the pelagic and benthic ecosystem dynamics (Bruce et al., 2005). In addition, some species from higher trophic levels such as bivalve or crustaceans like crabs spend the larval stage of their lifetime as zooplankton (Jak & Slijkerman, 2023). These are called meroplankton (Castellani & Edwards, 2017). Zooplankton species that are permanently free-floating in the water column are called holoplankton (Castellani & Edwards, 2017; Jak & Slijkerman, 2023).

Predatory

In the pelagic environment shelter opportunities lack for slow swimming plankton (Castellani & Edwards, 2017). According to Castellani & Edwards (2017), the only way to avoid visual predators in open water is to use camouflage through near transparency or specialized coloration and signal others using bioluminescence. Another strategy of zooplankton to avoid being eaten by predators is to migrate to the surface to feed at night and retreat into the depths during the day to keep away from exposing sunlight (Castellani & Edwards, 2017). Vertical migration of zooplankton, influenced by light, temperature, food availability, and predator presence, significantly impacts ecosystem dynamics, as predators adapt their behavior according to zooplankton abundance (Jak & Slijkerman, 2023; Castellani & Edwards, 2017). For example, some larger zooplankton such as jellyfish species feed on particular smaller zooplankton species by capturing them in their tentacles (Carr & Pitt, 2007). To escape medusae, some zooplankton have well-developed locomotory abilities and will migrate vertically away from the predators (Carr & Pitt, 2007). Also, research of Cohen (2003) shows that larvae of the crab *Rhithropanopeus harrisii* are able to detect the shadows of and chemicals released by the ctenophore *Mnemiopsis leidyi* and react. Zooplankton is hardly fished by man, so they are virtually independent of fishing intensity (Mortelmans et al., 2019).

Population trends

Research of Martens & Van Beusekom (2008) shows that rising temperature of sea water has a positive effect on zooplankton, especially the larvae of copepods in zooplankton rise in numbers. Due to the increasing autumn temperatures and extended growth season, hatching rates of many copepod species in the North Sea and Wadden Sea have gone upwards, which means more larvae and thus more zooplankton (Martens & Van Beusekom, 2008). Since copepods are an important food source for higher trophic levels, the food web depends largely on the abundance of phytoplankton and zooplankton (Martens & Van Beusekom, 2008). There were also some papers found about

invasive zooplankton species in the North Sea. For example, the invasive ctenophore *Mnemiopsis leidyi*, possibly introduced through ballast water discharge, was recorded for the first time in the North Sea in 2006 (Van Ginderdeuren et al., 2012). And the copepod species *Pseudodiaptomus marinus*, first reported in 2015, is now too thriving in the North Sea as a possible consequence of rising water temperature and chlorophyll a concentrations (Deschutter et al., 2018).

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